



UNIVERSITY OF CALGARY  
FACULTY OF SCIENCE  
DEPARTMENT OF PHYSICS AND ASTRONOMY  
COURSE OUTLINE

1. **Course:** ASPH 503 The Interstellar Medium                      Fall 2017

Dr. Rene Plume | SB 517 | (403) 220-6909 | [rplume@ucalgary.ca](mailto:rplume@ucalgary.ca) | Office hours TBA

Lecture Sections: LEC 1 | MWF    15:00-15:50 | ST 063

**Course Website:** [d2l.ucalgary.ca](http://d2l.ucalgary.ca)

**Departmental Office:** SB 605, 403-220-5385, [phasugrd@ucalgary.ca](mailto:phasugrd@ucalgary.ca)

2. **Prerequisites:** Astrophysics 213, Physics 325, 381, and one of Mathematics 349 or 375 or Applied Mathematics 307. Note: The Faculty of Science policy on pre- and co-requisite checking is outlined in the 2015-2016 Calendar. A student may not register in a course unless a grade at least "C-" has been obtained in each pre-requisite course; it is the responsibility of students to ensure that their registrations are in order. See <http://www.ucalgary.ca/pubs/calendar/current/sc-3-5.html> for details.
3. **Grading:** The University policy on grading and related matters is described sections [F.1](#) and [F.2](#) of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Assignments (5): 20% (Must be turned in at the start of class on due dates to be announced)

Observing lab: 20% (Observing lab report is due on Monday, November 30, 2015, at the start of class)

Midterm Exam: 20% (Wednesday, October 28, 2015, in class)

Final Examination: 40% (To be scheduled by the Registrar)

Bonus credit: Up to 3% for reading quizzes (to be announced)

A percentage grade will be determined for each course component. A zero grade will be entered for any course component that is not submitted by the due date, unless an exception was approved by the instructor. The over-all percentage grade of the assignments will be calculated as the average percentage grade of all assignments, with all assignments receiving equal weight. An average percentage grade for the course will be calculated using the weights of the individual course components. *In order to pass the course, a **passing grade** must be obtained for: 1. The observing project, and 2. The final exam.* Students with a failing grade for either the observing project, or the final exam, or both, *should expect a course letter grade not higher than D+, no matter what the over-all percentage grade of the course is.* Subject to the condition of a passing grade for the observing project and the final exam, the course grade will be determined from the average percentage grade using the table below. NOTE THAT THE PERCENTAGES IN THIS TABLE REPRESENT *MINIMUM* THRESHOLDS TO OBTAIN A CERTAIN LETTER GRADE.

The observing project will be done in small groups of 2 or 3 students. Each student is assigned a target star cluster by the instructor. The *group* will observe all open star clusters *for every student in the group*. A group's observations are finished only when each student in the group has the data required to finish the lab. Collaboration in processing of the data is encouraged. Each student will analyse the processed images of their assigned star cluster and submit a report following the instructions in the manual (posted on d2l). Grading for the observing project will include participation in the observations, image processing, and the individual report.

*Grading of the observing project:* Students will write a lab report following itemized instructions provided in a lab manual. The report will be graded on clarity, presentation of the observations, insight into the analysis, and discussion of the results. As astronomical observations depend on favourable weather conditions, students are required to begin the observing as early as possible. *Bad weather is not an acceptable excuse for a late or missing observing project*, and a zero grade will be entered for the lab if it is not submitted on the due date. Assessment of data quality is part of the project (insight into the analysis). It is the student's responsibility to contact the instructor if not certain about the suitability of the data to perform the project, or if any doubt arises during the analysis of the data. The grading of the report will take into account *method and discussion*, and acknowledge that there is no single correct answer when working with real-life data. The lab component is in part supervised by **Dr. P. Langill. The lab will be marked jointly by Dr. Langill and the instructor.**

**Reading quizzes.** We will organize a few sessions where students are asked to read a section of the textbook in advance. At the start of the session, students will answer up to 3 questions that require a very short answer. The remainder of the session will be devoted to questions and discussion related to the reading. A bonus credit up to 3% will be calculated, proportional to the total number of correct answers given in the reading quizzes.

Percentage to letter grade conversion scale:

> = 90 %	A +	> = 75 %	B +	> = 60 %	C +	> = 47 %	D +
> = 85 %	A	> = 70 %	B	> = 55 %	C	> = 45 %	D
> = 80 %	A -	> = 65 %	B -	> = 50 %	C -	< 45 %	F

4. **Missed Components of Term Work:** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in [Section 3.6](#). It is the student's responsibility to familiarize himself/herself with these regulations. See also [Section E.6](#) of the University Calendar.

5. **Scheduled out-of-class activities:** None.

**REGULARLY SCHEDULED CLASSES HAVE PRECEDENCE OVER ANY OUT-OF-CLASS-TIME-ACTIVITY.** If you have a clash with this out-of-class-time-activity, please inform your instructor as soon as possible so that alternative arrangements may be made for you.

6. **Course Materials:** *Physics & Chemistry of the Interstellar Medium*, Sun Kwok

**Online Course Components:** Lecture notes and slides will be posted on d2l.

7. **Examination Policy:** All exams are closed-book. All exams are cumulative. The exams can cover all subjects from set sections of the textbook, lectures, and assignments. A non-programmable calculator is required for all exams. Calculator applications on any device with wireless capability are strictly prohibited. Smart watches are not permitted in the exam room. Students should also read the Calendar, [Section G](#), on Examinations.

8. **Approved Mandatory and Optional Course Supplemental Fees:** None

9. **Writing across the curriculum statement:** Students are expected to write a report about the observing lab. Grading of the report for the observing project will be done on clarity of the description and discussion. The report requires brief

but complete descriptions of individual steps. Minor spelling or style errors will not be considered in the grading of the report, provided that statements are precise and unambiguous. See also [Section E.2](#) of the University Calendar.

**10. Human studies statement:** There will be no study with human subjects related to this course. See also [Section E.5](#) of the University Calendar.

#### 11. OTHER IMPORTANT INFORMATION FOR STUDENTS:

- (a) **Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under [Section K](#). Student Misconduct to inform yourself of definitions, processes and penalties.
- (b) **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on [assembly points](#).
- (c) **Student Accommodations:** Students needing an Accommodation because of a Disability or medical condition should contact Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities available at [http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities\\_0.pdf](http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf). Students needing an Accommodation in relation to their coursework or to fulfill requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to the Associate Head of the Department of Physics and Astronomy, Dr. David Feder, by email ([dfeder@ucalgary.ca](mailto:dfeder@ucalgary.ca)) or by phone (403.220.3638).
- (d) **Safewalk:** Campus Security will escort individuals day or night (<http://www.ucalgary.ca/security/safewalk/>). Call 220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.
- (e) **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence, students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information see also <http://www.ucalgary.ca/secretariat/privacy>.
- (f) **Student Union Information:** [VP Academic](#) Phone: 220-3911 Email: [suvpaca@ucalgary.ca](mailto:suvpaca@ucalgary.ca).  
SU Faculty Rep: Phone: 220-3913  
Email: [science1@su.ucalgary.ca](mailto:science1@su.ucalgary.ca), [science2@su.ucalgary.ca](mailto:science2@su.ucalgary.ca) and [science3@su.ucalgary.ca](mailto:science3@su.ucalgary.ca)  
Student Ombuds Office: 403 220-6420  
Email: [ombuds@ucalgary.ca](mailto:ombuds@ucalgary.ca); <http://ucalgary.ca/provost/students/ombuds>
- (g) **Internet and Electronic Device Information:** You can assume that in all classes that you attend, your cell phone should be turned off unless instructed otherwise. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.
- (h) **U.S.R.I.:** At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses ([www.ucalgary.ca/usri](http://www.ucalgary.ca/usri)). Your responses make a difference - please participate in USRI Surveys.

**Course Syllabus:**

**This course covers the distribution, dynamics, and physical state of matter (elementary particles, atoms, molecules and dust grains) in interstellar space, and its interaction with photons. Radiation transport and atomic physics are an integral part of the course.**

**Due to the nature of the course material, there will be more assignments in the second half of the term than in the first half.**

We will give a brief overview of measurement techniques, but this course focuses mainly on astrophysical concepts with attention to astrochemistry. We begin with an overview of the different phases of the interstellar medium, how they are observed, and an introduction to processes that change the interstellar medium. Principles of radiation transport, optical depth and applications of radiation transport in the interstellar medium will be covered. The concepts of local thermodynamic equilibrium (LTE) versus non-LTE are discussed along with some examples of LTE and non-LTE situations. We will discuss photo-ionization and recombination, photo-dissociation of molecules, and spectral line processes of atoms, ions, and molecules. We introduce concepts of forbidden, semi-forbidden and permitted transitions in an astrophysical context, and introduce collisional de-excitation and critical density. Cooling processes of the interstellar medium, the effect of metallicity on the rate of cooling. Continuum radiation processes will be discussed briefly. The nature of interstellar dust grains (size distribution, composition, PAH), interstellar extinction, scattering of light by small particles, thermal emission of dust grains and their relation to gas-phase chemistry will be discussed. Finally we will discuss the interaction between stars and the interstellar medium (stellar wind, supernovae, physics of shocks). If time permits, we will discuss photon dominated regions and young stellar objects in more detail. While the textbook for this course emphasizes astrophysical processes, the lectures and assignments will address practical applications for the atomic, molecular, and ionized phases of the interstellar medium. These processes will include spectral line opacity effects, population of energy levels, and molecules that trace species that are hard to observe, or certain density or temperature intervals. The interstellar medium in other galaxies will sometimes be discussed to provide context, or clarify certain points, but the subject of this course relates mostly to processes on scales that are most readily observed in the interstellar medium of the Milky Way Galaxy.

Department Approval \_\_\_\_\_ Date \_\_\_\_\_